Slide Rule and Slickers: The Making of a Tramp Miner

By
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I cannot remember when I first knew that I wanted to be a miner. Looking back over the years, it seems like it has been forever. By the time I graduated from Carlsbad High School in 1954, I was sure what I wanted to do for a career. I received a full tuition scholarship—fifty-five dollars per semester—to the New Mexico Institute of Mining and Technology, and a part-time job in the College Mineral Museum. I was not sure whether I wanted to study geology or mining, but since the courses were all common for the first two years, I had a bit of time to see which way I wanted to go.

By the conclusion of my freshman year I had reached the legal age to work in mines, so I returned to Carlsbad to a summer job in the Mine Engineering Department for U.S. Potash Company. The old U.S. Mine had been the first to be developed in the Carlsbad Potash Basin, and had been in operation some twenty years when I first arrived in 1955.

They were already starting to pull pillars in a portion of the mine, so our first assignment that summer was to install a surface subsidence grid over the pillar extraction area. The survey crew consisted of college students hired by the company from employees' families or, like me, were guys who held scholarships.

The job entailed installing steel rebar, cemented into a post hole dug by hand. The grid was a hundred by a hundred feet, so there were literally hundreds of installations to complete. The surface over the mine consisted of red sandy hillocks and mesquite bushes. The blow sand made walking difficult and the summer heat radiated from the sand as if the devil himself was breathing down our necks. It was here that I first learned the hard facts of working life; the undesirable tasks go to those with the least seniority.

The work was further complicated by the fact that the hundreds of mesquite groves were a haven for rattlesnakes. In fact, some groves were so infested that we had to literally blast the dens apart with sticks of dynamite. In those days, we were not particularly sensitive to the environment, especially when it came to dealing with those desert reptiles. So that summer we decimated the snake population of the sand hills while setting out the grid. It was menial work, but paid well: $1.25 per hour, as I recall.

I returned to Socorro in the fall, flush with money and one-half of the thousand-dollar U.S. Potash scholarship, which paid for my tuition and books. The job in the Museum provided spending money.

During that school year, in addition to my job at the museum, I worked each Saturday night at a local manganese mill. My job was to shovel out the tail pulley area of the ore belt to keep it clean. I shoveled the fines into a five gallon bucket and hoisted them to the top deck of the plant, where I then dumped them into the heavy media tank. It was both back breaking and monotonous, but it paid well: ten dollars for an eight-hour shift.

When Christmas vacation rolled around, I went back to U.S. Potash, this time as an underground surveyor's helper, a rodman. It was there that I first learned about "tommy knockers." In those areas where pillars were being removed, timber posts were set to hold the weight of the overlying roof rock. We would move among the timbers, setting line points for the miners, often crawling on hands and knees, sometimes in a crouch, but rarely standing upright.

Shining my cap lamp on the point to be established, I would wait for the transit man's signal that the point was properly lined up and the survey spad hole ready to drill. I would then drill the hole, insert the spad, and wait once again for the survey point to be confirmed. As I waited, I could hear the timbers creak and groan under the weight of the overburden, but not knowing the source of the noise, I inquired of the transit man. He was only too happy to share his knowledge of the "tommy knockers."

It seems that these elfin creatures follow the miners underground and inhabit the timbers. They constantly warn the miners to be aware of their surroundings by creaks and groans. As long as the timbers "talk," the tommy knockers are doing their job and the mine is safe. When the noise stops, it is a danger signal for the miners. The tommy knockers have left and the miners had best follow suit. I later learned the engineering explanation for the timber noise, but I have always liked the "tommy knocker" explanation better.

As my sophomore year drew to a close, I was informed that I would receive the entire U.S. Potash scholarship of a thousand dollars for the next year. I was offered the opportunity to work in the U.S. Potash refinery that summer, first as an evaporator operator's helper and later as an assistant in the research lab.

The evaporator was a huge cylindrical steel vessel, into which potash-rich brine was pumped. The vessel was sealed, operating under vacuum to remove the salt from the brine. The inside of the vessel would build up a salt layer that had to be washed away daily. The refinery had six of these vessels, each of which had to be cleaned by the three summer students assigned to the evaporator section.

We would take a vessel off line, open the inspection hatch, lean into the vessel and wash the salt from the walls with a high pressure hose. After the operator inspected the inside walls, we would replace the hatch, put the vessel under vacuum, and repeat the procedure with each succeeding evaporator. It was yet another affirmation that the dirty jobs were invented solely to separate the "wheat from the chaff" or "the men from the boys."

After about a month, I was transferred to a straight day job operating an experimental crystallizer in the refinery research lab. Much like the survey crew of the previous summer, our crystallizer crew was composed of college students. We

fed raw potash into the bottom of a tall column about three feet in diameter. The raw potash was forced upward through a solution saturated in NaCl.

When the solution became supersaturated, tiny crystals of potash began to form. As the crystals were borne upward through the brine, they grew in size until they became sufficiently dense to allow gravity to take over and began to fall downward through the column. The experimental unit was fitted with peepholes at different elevations to permit an observer to watch the crystals grow. We monitored the process parameters—temperature, vacuum, feed density, etc.—collecting data to design a production prototype. It was my introduction to the real world of chemistry.

It was also my introduction to organized labor. The mine and refinery were both unionized, but I had not interacted with union workers while working on the survey crew. In the refinery, it was a different story. We students were not members of the union, so our activities on the job were constrained. I first realized how much so when we burned out a pump motor one day. In order to change the pump, I had to call for an electrician to de-energize the motor. But he could not remove the motor from its base; that job belonged to a millwright, who could not remove the motor until a pipefitter uncoupled the motor from the pump.

A five minute job turned out taking a couple of hours and I thought to myself how ridiculous that jealous guarding of work was—and how unproductive! The pump change-out was etched indelibly into my mind, and it served as the basis for later experiments in redefining work that I introduced to the uranium industry in Wyoming.

At the end of my junior year, I declined an offer to return to Carlsbad, opting instead for a summer job with Anaconda in Butte, Montana. It was to be a summer I would never forget.

I showed up at the Anaconda personnel office downtown with my employment letter in hand. I was given a hiring paper and told to report to the rustling line at the Leonard Mine in Meaderville the next morning. I found the parking lot and wended my way past more bars than I had ever seen in my life. It was easy to locate the rustling line; there were probably twenty men standing before a corrugated tin shack at the entrance to the mine site. The headframe, hoist house, and dry room loomed in the distance.

In this dismal setting, the rustling ritual unfolded before me. A tall, lanky man in faded overalls and wearing a beat up old miner's hat sat before a window in the shack and interviewed each applicant in line. The routine went something like this:

Tall and lanky: "I need a motorman and two swampers today."

First in line: "I'm a miner, not no day's pay hand."

"Sorry, pard. No miners needed today. You might try the Belmont. Next!"

The ritual repeated itself until the day's labor requirements were met. As it happened that day, the window was still open when I reached the front of the line. Without a word, I thrust the hiring paper in front of tall and lanky and waited. He looked me up and down, shook his head and unceremoniously beckoned me to step through the gate. Thus my entrance into the world of hard rock mining, a world completely foreign to all that I had known.

I made my way to the dry room, found an empty locker for my street clothes and an empty basket for my "diggers". I had brought my hard hat, lamp belt, and rubber boots from Carlsbad. All I lacked was a set of slickers. Issued by the lamp man, and emblazoned with my name in black marker pen down each leg of the brilliant yellow pants, they silently shouted for all the miners to hear: "rookie," "new miner," "tenderfoot!" I could hardly wait to get underground and get them smeared with grease and drill oil.

I was assigned to work with an experienced

miner named Pete Verbanich, a quiet man in his mid-fifties. Pete was the quintessential teacher. Never in a hurry, he knew his craft well and was willing to pass along the basics in a usually non-verbal, but well-understood, way. I later discovered that he was not your typical contract miner, one who knew all the shortcuts and usually took them in order to increase his contract pay. Pete would take the time to explain the safe way to complete a task, all the while assuring me that speed would come as a result of repetition and that bad habits learned were very hard to unlearn.

We had a square-set stope on the 3300 level. When we would arrive at the stope, Pete would quickly assess the situation and determine the work sequence required. The mine worked two shifts, with a four hour period between shifts for the blasting fumes to clear from the stopes and levels. Usually, our first job was to bar down any loose rock from the back and ribs, checking to be sure that there was sufficient clearance to stand the next set of timber. Once the bar down was complete, I would climb the manway to the 3200 level, where we stored our timber. I would lower the posts, caps, girts, and lagging to the stope floor, and together we would block in the next set.

Once the timber was set and the ground supported, I would climb down to the grizzly level two sets below. There I would "run the rock" into the ore pass, from which it would be removed by the motor crew and trammed to the ore pocket at the shaft.

Running rock was generally the initial assignment for a new miner. It was hard physical labor, more taxing on the brawn than the brain. The grizzly had twelve-inch openings; you would work the muck pile atop the grizzly until an opening appeared. Once that hole in the pile was opened, you could begin to enlarge it. As boulders or slabs of rock too large to pass through the grizzly presented themselves, you had to break them with a double jack.

It did not take long to learn to look for cracks in the boulders. When you found one, a couple of well placed licks with the double jack would usually break it enough to let it pass through. It was quite tempting to try to work large, thin slabs through without breaking them, as it took much less effort. But as I would discover later that summer, if a slab caused a hang-up in the ore pass or chute below, it took much more effort and hazard to unplug than if the rock had been properly sized initially.

I was normally on the grizzly level midway through the first half of the shift, and it was here that I usually encountered our shift boss as he made his daily rounds. He would holler "nothin' down!" from the manway at the 3300 level, then quickly climb to the grizzly level. He was a small bowlegged man of Cornish heritage, a second- or third-generation Butte miner named Kale Southwick. Kale and his brother Larry were the shift bosses on the 3300 level. Later I would bump into Larry again in Grants, New Mexico, where he bossed for Anaconda in one of their uranium mines.

Kale was probably in his early thirties, relatively young for a boss, but enough older than me that I addressed him as "sir." Now I had been taught to use that word as a sign of respect, but Kale thought I was just being smart-alecky. He had not much use for engineering students to begin with, and even less use for one who was also a smarty. Our daily conversation usually followed the same routine:

"How she goin', pard," he would say as his head popped through the manway opening and his light shone on the muck pile over the grizzly.

"Just fine, sir," I would reply.

"I ain't no sir," he'd exclaim.

"Yes, sir," I'd answer back.

"Do I look like your Daddy, boy?"

"No, sir."

"Then why do you call me 'sir'? Call me Kale."

"Yes, sir!"

By this time he would usually become exasperated, let out a string of curse words, and climb on up to check on Pete. As time passed, we entered into an uneasy truce, and by the end of the summer were on a first-name basis. But I had learned a valuable lesson. The etiquette I had learned at home had to be put on the shelf once I entered the mine. I learned to address everyone as "pard," and found that not only was it an acceptable term of endearment, but it also saved me from having to learn everyone's given name or nickname.

Once the ore pass was full or all of the broken muck had been run through, I would return to the mining level to help Pete. While I had been running rock, he had been drilling out the next round, so he was usually ready to load the holes and set off the blast. The two of us would load the holes, first the primer—a stick of dynamite with a blasting cap inserted in it—followed by three more sticks of dynamite.

We used safety fuse to initiate the detonation of the caps, so after each hole was loaded, Pete would bunch the fuses into a bundle, carefully adjusting the length of a fuse to provide the proper delay for each hole. Once the fuses were bundled, Pete would cut the bundle perpendicular to the fuse length with his jack knife. He would then ignite the fuses by lighting the bundle half he had just cut, then rubbing it across the other half. The fuse bundle would begin to burn and Pete would proceed to take the bundle apart to assure himself that each individual fuse was burning.

While he was doing this, I would first climb down to the 3300 and post the blasting sign to block the manway. Then I would climb to the level above and remain there until Pete joined me to wait for the blast. We would each count the shots as the holes fired, double checking one with the other to make sure there had been no misfires. We would lay out a plank of lagging in the drift and have our lunch while waiting for the fumes to clear the stope.

The afternoon portion of the shift repeated itself and we would wind up with two rounds of advance on most shifts. This was enough to earn us twice "day's pay," which was about $16.00 per shift.

During the course of the summer, I also spent some time driving raises and drift headings. I learned to drill with a jackleg and to muck with an overshot loader. I also learned another lesson that has stayed with me. I had been told that you should never stand on the inside of a drift curve when waiting for an ore train to pass. One day I forgot. We were mucking out a drift heading, tramming loaded cars to the main line and moving empties into position behind the mucker by hand. I had moved an empty into position behind the mucker and my partner pulled it to the face with the mucker. After filling the car, he backed it out of the heading and around the curve.

Standing on the inside of the curve, I saw it coming but did not realize until too late that I was on the wrong side of the car and there was not enough clearance for me between the rib and the car. Well, I sucked up my gut as much as possible and felt the car squeezing me against the rib. Luckily, nothing broke, but I had an abrasion along my belt line that remained tender enough for the rest of the summer to remind me never to do that again. I began to learn that safety rules are developed for a reason.

On my final shift of the summer, I rode the cage to the surface and encountered a winter wonderland. The first snow of the year had left its fluffy white mark on my loaded car in the parking lot. For the first time in my young mining career, I said "deep enough" and headed the car southward.

I had outgrown my part-time job in the Geology museum and transferred to the Thunderstorm Laboratory to work inputting weather data into its R. and D. computer, to be used to model thunderstorm activity. The Magdalena Range and the San Augustine Plains west of Socorro were hosts to severe thunderstorms during the summertime and some of the Socorro professors were engaged in research, trying to understand the phenomena.

The job was not mining related, but it paid better than the museum and it allowed me to at least develop a speaking acquaintance with the world of computers.

I took the PE first exam that spring and became an engineer-in-training. I also served as president of the Cooney Mining Club, the student chapter of the AIME. I had joined AIME in 1956, but had to wait my turn to preside over the club. I entered a paper in the local chapter contest and won twenty-five dollars, plus an opportunity to present it to a chapter meeting in Grants. Things were looking up!

During my final semester, I began that inevitable job search that tends to define a career path for at least the first five years. I interviewed with Cerro de Pasco Corporation and was given a real sales pitch. I was about to take the bait, but decided to check with a friend of mine, a native Peruvian who had graduated the year before and had joined them at Mauricocha. The mine camp was at an elevation of fifteen thousand feet, the highest of all the Cerro mines and the one to which they loved to send new gringo engineers. When I found out that my friend could not work at that elevation, I declined the offer.

In the meantime, I had received an offer of an instructor position in the Mining Engineering Department of the Missouri School of Mines and Metallurgy. Under the terms of the employment offer, I could take six graduate credit hours per semester, thus allowing me to work on a master's degree. The annual stipend was four thousand dollars. With that offer in hand, I decided to move to Missouri at the end of the summer.

I also decided to forgo another adventure such as Butte, so I accepted a summer job with the New Mexico Bureau of Mines. That turned out to be one of the most important decisions of my career. It brought me my first mentor.

George Griswold was the mining engineer for the Bureau. A New Mexico Tech alumnus, George had just gotten his Ph.D. in Geology from the University of Arizona and had returned to Socorro. I worked as his field assistant on a number of projects and we became good friends. He taught me the practical side of mine mapping and mineral examinations. He also taught me how to survive on twenty dollars per diem in the field.

Our main project was to map and describe the mines and prospects of Lincoln County, New Mexico. We worked out of Carrizozo, spending the weekdays in the field and weekends at home. We mapped rare earth and fluorspar mines in the Gallinas Mountains, the gold mines at White Oaks, base and precious metals prospects around Nogal Peak, and iron deposits in the Oscuras. The variety of geologic settings and mineral assemblages made each day in the field a true adventure.

In addition to our work in Lincoln County, George and I mapped many of the newly developing uranium mines in the Grants area. It was my fist encounter with a mining "boom." Uranium ore had been discovered a few years earlier at Haystack Butte, west of Grants, by Navajo sheepherder Paddy Martinez. That discovery set off a frenzy of exploration activity and led to the development of the world-class deposits of Ambrosia Lake. Suddenly the sleepy little railroad town of Grants was overflowing with prospectors and drillers, miners and mine suppliers. George and I booked lodging by the shift. When we left for work in the morning, our rooms would be occupied by miners coming off a graveyard shift somewhere. It was wild!

Ambrosia Lake was an old dry playa on the surface, but saturated underneath. The porous sandstone that hosted the uranium deposits yielded its water copiously. The water flows were not predictable by known hydraulic models, a fact that I tucked away in a corner of my mind, thinking that it might come in handy somewhere down the line. Sure enough, it did!

By late August the field work was largely complete, so my young family and I packed all our belongings in a U-haul and set our sights on Missouri.

Mining students at Missouri Mines were required to take a two week summer surveying course between their junior and senior years. It was a practical course, comprised of closed traverses in the underground headings of the school mine, shaft plumbing, surface mapping with plane table and alidade, and preparation of a finished map of the mine. Diligence and organization were required if each three-student team was to complete the work satisfactorily. My contract called for me to teach this course.

We arrived in Rolla, checked into a cheap motel, and I reported for work. I quickly discovered, once again, the meaning of seniority. None of the other staff would touch the summer course with a ten-foot pole. Not only did one have to report for the year two weeks early, one had to manage five to six teams of students, each team trying to outmaneuver the others in an underground mine of limited headings. To top it all off, the gnats, flies, and chiggers had been waiting all summer for just this time. Guess they could tell a good meal when they saw it! In spite of its drawbacks, the summer camp gave me a unique opportunity to get to know the students. We made some lasting friendships that continue to this day.

My office was located at the end of the main corridor of the Mining Building. Easily accessible, it soon became a focal point for students who needed help or, more often, just wanted to talk. The adjacent office was occupied by one of the senior staff, an associate professor, Carl Christiansen.

Carl was a graduate of the two-year program at Wisconsin Tech who had transferred from Platteville to Rolla for his bachelor's degree. After serving in WWII and a few years spent working for New Jersey Zinc, he returned to Rolla to get his master's degree and stayed on to teach. George Griswold had taught me how to be professional as an engineer and Carl taught me how to be professional as a teacher. I literally sat at his feet, learning how to prepare lecture notes, how to be an effective lecturer, when to lecture and when to have discussion, and how to prepare exam questions to assure that a student had learned the material.

I think that the same person who developed shift schedules in the mines was also responsible for creating class schedules at Rolla. One thing I learned for certain was that I drew the 7:30 a.m. classes, as well as the 1:00 to 4:00 p.m. labs. If there is anything more frustrating than trying to keep the attention of juniors and seniors—who already think they know more than the professor and have partied hearty the night before—I have yet to discover it. That is why junior staff drew these classes. The dialog would often go something like this:

"Today we are going to discuss the proper loading and wiring of a burn cut drift round," I would begin. That statement was usually met by stony silence, occasionally interrupted by a faint snore from the back of the room.

"Can anyone come to the board and sketch out a burn cut pattern?" Again, silence. Maybe some feet shuffling uncomfortably.

"How about you, Mr. Smith?" The name of the student is unimportant; they all reacted essentially the same.

"Who, me?" responds Smith.

"Yes, you!" I reply.

"Uh, what chapter was that in?"

"Your assignment was chapters eight and nine."

"Oh, I thought it was chapters six and seven. That's what I read. "

If I was lucky enough to find someone who had actually read the lesson, we could proceed. Otherwise, we'd backtrack and repeat yesterday's lecture or discussion. Amazing as it may seem, most of the students managed to eventually pass the course, graduate, and make their own mark in the mining industry. I can count several company presidents and vice presidents among my students.

In my first couple of years at Rolla, a sizable

number of my students were older than I. They were mostly veterans, returning to college on the G.I. Bill, and a number of them had worked in the Illinois coal mines or in the lead mines of southeastern Missouri. Put them in the same classroom with a wet-behind-the-ears instructor who had himself just graduated and you had the potential for real conflict.

It was in this setting that I learned another lesson that would serve me well over the years. I resolved that I would not try to pretend that I had all the answers, but would encourage the students to provide input to class discussions, based on their own experience. By so doing I could better keep their attention focused on the subject matter, and often I would learn a better way of approaching the solution to a problem. As the years passed, this approach kept me from making some grievous mistakes and gave me the comfort of knowing that I could get "buy-in" by involving others in the decision making.

The Mining Department at Rolla was rich in terms of experimental equipment. I can remember that at Socorro, when we wanted to drill a drift round in the school mine, we had to set a jack hammer in a homemade pipe cradle, euphemistically known as a "Mexican jackleg." Rolla had twenty or thirty drills, all of recent vintage and in good working order. There was a ventilation lab at the school mine, complete with a fully instrumented axial vane fan, and duct work tying the fan into the mine workings through a vent shaft.

We also had a complete machine shop for fabricating the instrumentation and metal pipes used in explosives research. An instrument truck was outfitted with oscilloscopes and a high-speed camera for recording the detonation pressures and velocities of various explosives compounds. Dr. George Clark, the department chairman, was a pioneer in the commercialization of ammonium nitrate–fuel oil (ANFO) blasting agents. He had a Ph.D. from the University of Illinois and had the entire department immersed in ANFO research. We had a test range at Fort Leonard Wood, west of Rolla. There we were truly "pipe bombers," a terminology that carries a far different connotation today.

We had one of the largest centrifuges for rock mechanics studies in existence at that time. Built with a grant from the National Science Foundation, the machine was around twelve feet in diameter, three feet in thickness, and capable of producing g-forces equivalent to the pressure exerted by eight thousand feet of overburden. Composite roof beams could be tested to determine maximum room widths, useful knowledge in designing room-and-pillar mines. Different opening shapes could be cast in gypsum molds and subjected to increasing stress to determine optimum opening size and shape.

By the end of my first year, I had taught two semesters of Mine Surveying, two semesters of Explosives and Blasting, one course in Mining Geology, and a Mine Design Lab. My own graduate studies included Differential Equations, Theory of High Explosives, Rock Mechanics Design, and Groundwater Hydrology.

During the summer of 1959, I worked for the U.S. Bureau of Mines at the Rolla Mining Research Laboratory. The Rolla facility was primarily a metallurgical research lab, but with a contingent of about four mining engineers engaged in research known only to them. The procedure for securing approval of a research project was one of self-initiation. If the supervisor liked a proposal, it was likely to be funded; if he did not, just the opposite would occur.

I approached Bill Miller, the supervisory mining engineer, with a proposal in the early spring of 1959. I had heard horror stories about the unpredictable flows of sub-surface water encountered in the development of the underground uranium mines at Ambrosia Lake when George Griswold and I worked there the preceding summer. I had heard similar stories coming out of the New Lead Belt, a district west of the "Old" Lead Belt in southeastern Missouri. I proposed to develop, through modeling, a more reliable method

of predicting influx into an underground mine. I had the idea, but absolutely no plan for carrying it out.

Well, Bill liked the proposal and, since all the other work underway related to attempts to muffle the exhaust noise from a drill, I think he wanted the project just to provide some variety. I worked directly with Jack Chester, a mining engineer with a degree from the Colorado School of Mines. Jack had worked at El Mochita in Honduras before joining the Bureau.

Over the course of that summer and the next, we conducted field tests at a development project near Fredricktown, Missouri, first controlled by the National Lead Company and later by Bunker Hill. It was a cobalt prospect that contained an un-removable quantity of subterranean water in the Bonneterre formation that hosted the mineral deposit.

I remember one test in which we injected fluorescein dye into an exploration hole, trying to determine the flow path of the water stream. About an hour after injecting the dye, we were busily sampling well points in the vicinity of the injection well. The noise of an approaching pick-up, sans muffler, anticipated our being assailed by an irate farmer.

The dye had appeared in his farm well and he was sure we were poisoning his cattle. Despite our protestations to the contrary, he could already see dollar signs, particularly when he discovered that this was a government test. Jack finally convinced him to go home and check on the health of his cows and return if any showed signs of illness. He never returned and we never found the channel through which the dye flowed.

During the second summer, 1960, our research turned, perhaps because of our experience with the irate farmer, to a scale modeling exercise. We created an electric field within a large piece of blotting paper saturated in brine. Fluid flow could be simulated and the effect on the flow of a circular hole—i.e. a shaft—studied. We spent most of the summer designing the experiment and establishing flow and rock parameters. The few test runs we made were inconclusive and I returned to school that fall convinced that here was a practical thesis project, but one that would require a different approach.

I began my thesis research that autumn while continuing to carry a full teaching load. In addition to the regular subjects I had been assigned, I began to teach undergraduate rock mechanics. It was an area of mining that I had not been exposed to at Socorro and I felt that if I became proficient in applying the theoretical to mine design, perhaps I would be able to carve out a niche that would help me advance more quickly once I got back into industry. Remember, I viewed my sojourn in academia as only a slight detour on my road to mining fame and fortune.

I developed a "quick and dirty" mathematical model for estimating groundwater flow into a vertical shaft, then tested the model against conclusions drawn using conventional well tests and hydrologic flow analysis. The model checked reasonably well against data from Ambrosia Lake provided to me by Homestake Mining Co. I was able to satisfactorily defend my thesis and was granted my master's degree in January 1961. I later distilled the essence of this work into a paper published in *Transactions* of the AIME.

A mining hydrology textbook, published by the Society of Mining Engineers in 1986, further validated my work by comparing it to a study in 1979 that produced similar results. The authors of the textbook stated that these two studies were the only ones that they had found that addressed the practical application of flow into a shaft. I had always thought that graduate research was supposed to produce results that were not only scientifically valid, but also unique. I never expected, however, to find my work still quoted in the literature thirty-five years after its completion. Needless to say, I was proud of that research.

Since I had completed my master's degree at the end of the fall semester, but my teaching contract ran through June, I decided to begin a

doctoral program. Because of my increasing interest in practical rock mechanics, I took courses in photoelasticity and mechanical vibrations, structural geology, fluid mechanics, foundation design—anything that I thought would increase my knowledge of the subject.

I also began to lay the ground work for obtaining a grant for doctoral research, since I would have to relinquish my instructorship for at least a year and enroll as a full-time student. With four mouths to feed, it seemed to be the only way to go. It never occurred to me to apply for a loan to see us through.

I wanted to use the department's centrifuge to study the effects of various types of roof bolting apparatus on opening stability. I thought it would be a good project, but the department head, Dr. Clark, thought otherwise. Because he was interested in high explosives, he could not imagine that everyone else in the department did not share his enthusiasm. I agreed to take some coursework and help in his ongoing research, but my heart just was not in it. I even agreed to work the next summer blowing up pipes at Fort Leonard Wood, hoping all the time that the good doctor would relent and throw his support behind my proposed research.

My summer at Fort Leonard Wood was cut short by an emergency appendectomy in July. Any residual enthusiasm for the work, if I had any, disappeared along with my appendix. I had, however, signed a new teaching contract, so I was stuck there for at least another year.

I completed the foreign language requirement and required courses for my doctorate, all the while trying to convince Dr. Clark to support my application for a National Science Foundation grant. It was like trying to force a stubborn jackass to obey instructions. By early spring, I had convinced myself that unless I wanted to do explosives research, I would have to find another job. Being as stubborn as he was, I refused to budge and so, effectively and efficiently, cut off the limb on which I perched. Having done so, I answered an ad in one of the trade magazines for a mining engineering opening at a potash mine being developed in Utah. After several telephone conversations, I was invited to make a site visit.

Texas Gulf Sulphur Company had acquired some federal leases in the Paradox Basin and had discovered a potash deposit adjacent to the Colorado River gorge, south of Moab. They were spending what at that time seemed like an enormous sum, around $65 million, to construct a mine and plant to compete with the mines in New Mexico. When I first visited, the permanent headframe had been erected and the contractor was setting a new Koepe hoisting system in place. I had seen a Koepe winder at the Pea Ridge iron mine in Missouri, but never of the size of this one. It was designed to hoist two ten-ton skips of ore every minute from a depth of three thousand feet.

I was met by the mine superintendent, Ken Kutz, a slender, young Canadian mining engineer. When I saw how young Ken was and the level of responsibility he had, I was easily convinced that my progress with TGS would be self-limiting, and I felt I had no limits. I met Jim Ogg, the project geologist, and Ed Ziolkowski, a senior engineer from the Michigan iron range. Both Jim and Ed were graduates of the Colorado School of Mines, but I never held it against them. We used to kid around in the lunch room that if one couldn't afford a college education, CSM was the next best thing.

I returned to Rolla with an offer in hand; I would be the rock mechanics engineer at the handsome sum of six hundred dollars per month. And the company would move our household goods and provide temporary housing. I thought I had died and gone to heaven! I turned in my resignation, effective at the end of the school year. In early June, my family and I bid farewell to Rolla and an unfinished Ph.D. and turned our hearts toward our new home in Utah. I was well on my way to becoming a tramp miner. It has been said that a successful career is built on a foundation

of education and experience. That has certainly been true of my "tramping."

I spent four years in Moab, helping in the development and startup of the Cane Creek mine for Texas Gulf. As their rock mechanics engineer, I put my academic training to use in designing room and pillar dimensions and monitoring subsidence in the deepest potash mine in the United States. During development of the mine, a methane explosion took the lives of many of the contractor's employees with whom I worked, an experience recounted in the 2009 issue of this journal.

I was promoted to mine research engineer and participated in the deployment of continuous mining machines in the undulating ore body. Ultimately the severe folding of the orebody proved too much for a conventional mining operation and the mine was converted to a solution mine. Fifty years later, the mine still produces potash.

I got an itch to try my hand at supervision and was once again promoted, to mine construction foreman. My crew and I excavated ore bins, installed conveyor belt lines, and moved materials in and out of the mine on the off-shift. I relied on my academic background in explosives and mine planning to compensate for my lack of supervisory experience. I was blessed with a crew of seasoned miners who were more than willing to mentor their much younger foreman. After the requisite five years of experience as an engineer, I passed the examination and became a professional engineer.

Heady with my new P.E. license, my first experience at supervising a crew, and itching to apply what I had learned about mine development, I jumped at the chance to return to Missouri as a mine foreman for Ozark Lead Company, a Kennecott subsidiary. This new mine was being developed through a large-diameter drilled shaft. The shaft was too small to lower large pieces of mine equipment, so we had to disassemble the drill jumbo and the LHD, lower them to the station and reassemble them. The mine made a very large amount of water, often flooding the drifts when our diesel generators failed.

On this job I experienced my first confrontation with organized labor since my summertime experience of years before. The United Steelworkers made a run at organizing the workers and capitalized on an employment incident between one of my crew and myself. I had a mechanic who was not performing satisfactorily and we were experiencing much downtime on the equipment. After repeated counseling, I let him go. I did not know at the time that he was one of the union's plants. Immediately upon termination, he filed a complaint with the National Labor Relations Board. Our H.R. manager, not wanting to create an issue, reinstated the mechanic without my knowledge. When I found out what he had done, I decided it was "deep enough."

It did not take me long to find another job. I was approached by Kerr–McGee Corporation and offered a job in the company's Plant Foods Manufacturing Division, working out of Oklahoma City. I spent the next two years doing long-range planning for a potash mine in New Mexico and a phosphate mine in Florida. Once again, my academic experiences provided the foundation for growth in my mining engineering expertise.

In 1968, I transferred to the Nuclear Corporation and went to Wyoming as superintendent of planning and engineering for their new operations in the Shirley and Powder River basins. We developed the Walker pit in Shirley Basin by diverting the Little Medicine Bow River, which ran through the middle of the deposit. It was an opportunity to dredge up some old notes and recollections of handling mine water at Ambrosia Lake, New Mexico.

After the mine was developed, I accepted an offer from Humble Oil and Refining Company (Exxon) to manage development of their Highland mine in the Powder River Basin. When I arrived on site, snow still covered the rolling hills and I discovered that "Blizzard Heights" was an aptly named landmark. Working for Humble allowed me much latitude to implement ideas that

had been germinating in the back of my mind. Many of the innovations at Highland have become commonplace within the industry, and are discussed in the 2008 issue of this journal.

After almost eight years at Highland, the tramp miner syndrome kicked in again and I returned to Kerr–McGee for another stint. I had learned never to burn my bridges when I left an employer. I hired on as general manager of New Mines in the Nuclear Corporation and immediately embarked on a massive shaft sinking venture.

We had our own construction company, Mine Contractors, Inc, headed by a wise old Boyles Brothers superintendent, Frank Peters. Frank and I were like oil and vinegar; we often clashed, but worked together effectively. We had two active sinking jobs and seven new mine projects on the drawing board.

It was a hectic time, shuttling between projects in New Mexico and Wyoming, interspersed with occasional assignments elsewhere in the company. But it all came to an abrupt halt when a contamination incident occurred at the Three Mile Island nuclear power plant in Pennsylvania. We immediately began to shutter projects and within eighteen months we were out of the uranium business.

With nothing better on the horizon, I accepted a position in Kerr–McGee Chemical to run their operation solution-mining sodium carbonate at Searles Lake, California. They had built a large carbonate plant at Trona, but were unable to maintain sufficient brine production to keep it in continuous operation. Because of my experience solution mining uranium, Mr. McGee and Frank McPherson, president of the corporation, urged me to take the job.

We modified a well-field flooding technique from the petroleum side of the business, then learned by trial and error how to keep injection wells open, produce a steady brine flow, and maintain the integrity of the production wells. Although challenges remain to this day in the plant, the mine has produced an adequate supply of brine for almost thirty years.

After getting the mining process working smoothly, I was promoted to manager of Soda Products Operations, responsible for three chemical plants, a coal-fired power plant, a quarry, and the lake operations. It was in this position that I began to learn about industrial minerals marketing.

As an operator, I had learned how to control costs without sacrificing safety or production, but now I had to learn the marketing and distribution side of the business. Customer trips, complaints about product quality, distribution logistics, and customer relations were all new and unfamiliar, but I was a fast learner.

We produced a variety of boron products, sodium sulfate, sodium carbonate and bicarbonate, as well as potash. Each product had its own market idiosyncrasies. Some products were seasonal, others had steady, year-round demand. All had to be transported—by truck, train, barge or ship. And customer relations varied from the "good ol' boy" handshakes that often characterized the fertilizer buyers to the sophisticated requirements of the chemical commodity brokers. I hearkened back to my teaching years, remembering how I learned to handle the mosaic of student personalities.

After eight years in the chemical business, the "tramp' instinct drew me back to mining, and I also wanted to return home to New Mexico to be close to my aging parents. I was offered a mine superintendent's position with Western–Ag Minerals Company in Carlsbad. It was a chance to once again don a set of slickers and get back to my roots. The company had purchased a very mature operating mine from Pennzoil (Duval). The potash mineral the operation mined and processed was langbeinite, a double sulfate of potash and magnesia. It was hard ore that had defied continuous mining techniques and secondary pillar recovery.

We began discussions with the Colorado School of Mines and Joy Manufacturing about

designing and building a continuous miner to effectively and efficiently cut the hard ore. Several years of lab and pilot experiments led to the development of a miner that could do the job. We leased the first machine and soon other companies became interested. The machine is marketed today to the trona and gypsum industries.

We also entered into a contract with New Mexico Tech to install a subsidence measuring system in an area of the mine where we wanted to pull pillars. The system measured separation of the roof layer from the overlying mud seam. Separation always preceded roof failure, so the system was an early warning of impending roof collapse. By continuously recording the separation, we could determine when it was no longer safe to continue removing pillars. The technique contributed substantially to the productivity and economic viability of the mine. We never experienced a roof collapse, nor did we experience any injuries.

After a few months at the mine, I was promoted to general manager, and put my Kerr–McGee-acquired marketing skills to good use. We developed several new products and customized our distribution system to meet the flexible schedule of our many truck customers.

After three years at Carlsbad, the company asked me to move to northern Nevada, where it was experiencing start-up problems with a new gold mine. I transferred as vice president of operations for Rayrock Mines, the company that owned Western–Ag.

In Nevada, I was responsible for the Dee, Marigold, and Pinson mines. Each of these mines was jointly owned, but each was operated by Rayrock. Here I rubbed shoulders with Barrick, Newmont, and Santa Fe executives, as well as with a few independent prospectors. Once again, this novice gold miner drew from prior experience the lessons needed to be able to guide a mine through the divergent interests of the stakeholders to economic success. After several years, we developed another gold mine, the Daisy, in southern Nevada.

I became vice president and chief operating officer of Rayrock Mines, Inc., in 1995. In that capacity, I assumed the additional responsibility for two developing projects in Latin America, both of which were experiencing the usual start-up blues.

Bellavista was a gold prospect adjacent to a rainforest preserve in Costa Rica. Because of the sensitive location of the deposit and the major impact it might have on eco-tourism, it had been tied up in the permitting process for several years. I wish I could say that the obstacles were overcome and the mine became a rousing success, but I cannot. After much hard work and dollars spent, the project was farmed out and has never reached operational status.

Mina Ivan in northern Chile was another story. A small, high-grade copper deposit situated on the seacoast near Antofagasta, it proved to be quite successful. There we first applied bio-leaching to recover copper solution from the ore. That pregnant solution was piped to an SX–EW plant that produced copper cathodes "five 9s" pure. The SX cells were of French design and, despite cries of doom from some of our competitors, were a success. Here we also employed our first "mass blast" of an underground pillar. Again, I drew on my experiences of long ago as a "pipe bomber." We brought down four hundred thousand metric tons of ore in a single blast and removed the broken ore through draw holes, just as one would in a block caving operation.

In 1999, the mergers and acquisitions mania hit us, as Glamis Gold (now Goldcorp) purchased Rayrock. Mina Ivan was sold to a Peruvian mining company and is still a successful operation. Daisy was mined out and shut down. Dee and Pinson were peddled to Barrick. Only Marigold remains in the Goldcorp portfolio.

Brass parachute in hand, I moved back to Carlsbad—but not for long. The tramp in me showed itself once again, this time in an entirely different way. An old mining buddy who headed a Christian relief and development company, Joint Development Associates, asked me to come

on board as vice president of development. Soon my wife and I were on a plane for Tashkent, Uzbekistan.

Our company was working in the poorest region in the country, an area that encompassed the Aral Sea, arguably one of the planet's worst environmental disasters. We drilled water wells, developed a chalk manufacturing business, demonstrated the solar disinfection of water, and carried on many relief projects. These community development activities are described in a paper published in *Mining Engineering* in 2005.

After three years with JDA, we returned to Carlsbad and I accepted a position in the local community college as an instructor and the manager of their vocational education program. I taught applied hydraulics, machinery lubrication, pneumatics, and facilities maintenance, along with short courses for the local mines. I soon discovered that the academic environment nowadays is much different than when I was at Rolla, so when my contract terminated I was on the lookout for a final(?) tramping opportunity.

I joined UOP, LLC (a Honeywell company) as a contract employee, hired to manage its zeolite mining operations in the high desert of southeastern Arizona. That has been my employer for the past five years. I manage a contract crew, whose average age is only slightly less than my own. We produce an environmental product used worldwide to clean chemical processing streams. And my quest for learning has not diminished. Just last year I became a certified mine safety professional (CMSP) by examination.

Looking back over fifty-plus years of tramping, I continue to believe that the first five years of a career determine the course of those that follow. I also think that one cannot easily separate the academic from the practical—the slide rule from the slickers—both are integral to success.

I suppose that one of these days I will hang up my slickers, put away my slide rule and say to this life: "deep enough." Then I will continue my search for El Dorado in the eternity prepared for my arrival—a tramp miner to the end!

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